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User empowerment and advanced public transport solutions

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Abstract

Local Public Transport is vulnerable to reduction of public funding even when users' expectations increase. The only way to develop and maintain adequate levels of service may be to promote solutions that rely on additional (cheap) resources. Those resources can be the users themselves, with their always-on personal devices and their willingness to participate in the improvement of this critical sector. This paper aims to show that more than competition and liberalization are needed to improve public transport services; the users' positional disadvantage must be reduced and lack of power remedied. Infomobility should be personalized based on individual user preferences. Users should be empowered to influence the service, which will give flexibility to the system and foster bottom-up development. They can become partners in the design and innovation of public services and entrepreneurs in the exploitation of new services. The different levels of user involvement are described. In a traditional approach, user participation can be relatively passive: the Public Transport Service Provider can adopt models to capture and analyze patterns of user behavior. Public authority and service providers can rely on infrastructures, including sensors, probes, and bidirectional communication channels, of nearly zero cost for the transport operators. Following a widespread trend and the development of information technologies and social media, users can participate actively, even contributing to the design of new solutions. The paper, based on the recent literature on user-driven innovations, illustrates modes and roles of user participation in transport services, provides evidence of the feasibility of active user participation in innovation and design, and introduces design schemes that exploit information and telecommunication technologies, social networking, and crowdsourcing to involve users in the design and improvement of transport services. The final remarks outline a strategy in three steps to empower users and improve public transport services.

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Keywords: Public Transport Services; crowdsourcing; collaborative service design; traveller information.

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1. Introduction

Local public transport has repeatedly been subjected to reduction of public funding. This has not marked a shift in favor of more productivity, but has resulted in increased prices and decreased quality and quantity of services.

Public authorities (PA) certainly need to increase competition, liberalize local transport services, and assign the unprofitable ones by tender. But these choices must be accompanied by the empowerment of the currently passive user of the services, planned and managed by the PA and Public Transport Services Providers (PTSP) with the help of their technostructures. In fact the several actors in local public transport – users, administrations, and providers of services, technology, and information – interact with different roles and responsibilities, but also with different leverage, to achieve their own objectives and benefits. For more efficient and sustainable transport services to be implemented, the users' positional disadvantage must be reduced and lack of power remedied. Finally, PA have to rely on advanced technologies to support the users' new role and to improve productivity and quality of public transport substantially. Many new technologies are available to support innovations.

Indeed, social media seem to be a very suitable tool for enhancing information systems on transit and to improve transit performances in general. So many messages to social media originate on a mobile device that it is easy to imagine that a significant number of their senders are sending them while riding the bus. These rider-senders could well be enlisted in an exchange of information and messages on personal experience of use to themselves and other riders.

Nunes et al. (2011) investigate this important issue further and introduce a model for cooperative exchanges of information in a public transport environment, where users can receive, supply, or evaluate information provided. Additional information, such as punctuality, noise levels, and assessments of driver skills, referenced to particular vehicles, routes and times, can also be obtained.

A recent survey conducted by Bregman (2012) on the use of social media among transit agencies in the United States and Canada found that about one third of the agencies responding to the survey already had a social media policy and that more than half had one in development.

Chaves et al. (2011) present the results of a survey of public transport users that investigates how collaborative systems based on social networks and collective intelligence can support sharing information with passengers. The results show that there is a scarcity of ways to obtain real-time public transport information and that the use of social network applications and collective intelligence is an interesting way to share and obtain this kind of information.

As a matter of fact, these media have proved very effective in supplying information under exceptional conditions. For example, transit operators and agencies have experienced a high increase in social media communications in the UK during the coldest days of winter (Austin, 2011).

Vieira et al. (2012) investigate how computational context and ubiquitous computing can be applied to Intelligent Transportation Systems (ITS) to aid bus passenger mobility in cities, since dynamic real-time factors can affect transport means.

Very recently, following the successful experience of crowdsourced navigation products for car drivers, such as Waze (Marjanovic et al., 2012), a few similar products have been introduced for public transport. Moovit is a free crowdsourced transit app for mobile devices that integrates public transit schedules with data transmitted by users passively and anonymously during their trips. Users also contribute so-called "tidbits" of information about available seats, delays, and cleanliness. Users can also provide information back to the system about whether the time estimates were accurate.

However, the full potential of social networking media has not yet been fully exploited, and they are still mainly used to provide one-way information to riders.

The objective of the paper is to go further on these issues, examining different opportunities provided by new information and communication technologies for empowering users in order to improve design, use, and operations of public transport systems. The paper is organized as follows. Section 2 describes recent studies and surveys on the effects produced by current information systems on users' behavior and transit system performances. Section 3 introduces some general requirements for an advanced concept of "infomobility" and defines different levels of information with an increasing level of participation and completeness. Section 4 discusses some opportunities provided by the wide use of information and communications technology on the Web and introduces an innovative crowdsourcing process that empowers users, enabling them to participate in various way in the design and management of services. Finally, the innovation process of public services and the interactions among the main actors are described in Section 5, which also presents an interpretive scheme of the provider motivations and the users role in public services. A section of final remarks concludes the paper to summarize the findings and outline a strategy for the decision maker in three main steps.

2. State of the art

Information systems for transport users have been studied by scholars and practitioners for many years. Surveys and experiments have highlighted the importance of personalized, reliable, and up-to-date information (Hickman & Wilson, 1995; Abdel-Aty, 2001; Watkins et al., 2011; Sun et al., 2013). Several studies have stressed the importance of the psychological effects of information on users' perception of travel. The results regarding potential increase of modal share for public transport when information is improved are, however, inconclusive. Dziekan and Kottenhoff (2007) identified, from a literature analysis, seven main effects of traveller information systems at bus stops: (1) reduced wait time; (2) positive psychological factors, such as reduced uncertainty, increased ease-of-use, and a greater feeling of security; (3) increased willingness-to-pay; (4) adjusted travel behavior, such as better use of wait time or more efficient travelling; (5) mode choice effects; (6) greater customer satisfaction; and (7) better image. Several studies concluded that an important effect of at-stop real-time information is a reduced perceived wait time: with real-time information, travellers overestimated their wait times by 9–13%, as against 24–30% without it. Avineri and Prashker (2006) remarked that the propensity of travelers to minimize expected travel time is not necessarily greater when information is provided. To account for this result, they believe that information increases the heterogeneity of travelers' choice. On the other hand, it is commonly acknowledged that information systems can improve users' travel time significantly in conditions of severe non-recurrent congestion and by only a small quantity in standard conditions. Information can, however, improve travelers' departure time choice and thereby reduce door-to-door journey time and increase the reliability of arrival time at destination. Grotenhuis et al. (2007) investigated users' needs and pointed out that users require additional information besides minimum time routes.

With regard to mode choice effects, it is unclear whether traveler information can improve public transport modal share. While several studies predicted an increase in passenger demand of up to 10%, empirical evidence rarely exceeded an increase of 3% (Holdsworth et al., 2007). Nevertheless, in almost all surveys, a large majority of users found the service useful. Tang and Thakuriah (2012) conducted a wide semi-experimental analysis of real-time transit information in Chicago and found that the provision of bus tracker service does increase bus ridership, although the average increase can be estimated as only about 2%. Chorus et al. (2007) addressed the role of behavioral factors in specific travelers' perception of their own knowledge levels and investigated travelers' need for a number of more advanced types of travel information, such as personalized early warning functions, concluding that types of information that make travel easier are needed. Molin and Timmermans (2006) conducted a joint choice experiment, which showed that willingness to pay for Internet-based service increases when functionality is added to the Internet-based system, principally real-time information. A recent study by Ferris et al. (2010) highlighted that users' needs vary with age. Specifically, 80% of people over 60 need information not only about routes but also about transit connections, while this is requested by only 40% of young and middle-aged people. Two consecutive surveys to travelers provided by Skoglund and Karlsson (2012) showed that the information provided by a travel planner was trusted, but that the perceived value of the service decreased over time.

Dziekan and Dicke-Ogenia (2010) tackled the capability of transit information systems to reduce travelers' uncertainty and remarked that the traveler as an individual is often not taken into account. They supposed this was because "the information provided is the information that the engineers think is important, while the traveler may wish for another type of information." This remark points up the need for a sound multidisciplinary approach to design of traveler information systems, according to which both technical components of devices and software specifications should be consequential to the design of functional features of the system, as would result from comprehensive analyses of users' needs. Lyons and Harman (2002) pointed out that public transport providers need to carry out effective market research on the needs for services and facilities and suggested this market research might also focus on employers and services providers, to identify the opportunities for developing public transport and to meet the needs of their employees and clients.

A recent paper by Nelson and Mulley (2013) provides a critique of methods adopted in the use of ITS by comparing experiences in Europe and Australia. They note that the journey planning experience needs to be supported by access to information that is user-friendly, user-empowered, reliable, and efficient. It envisions the potential role of users' participation in social networking, whereby passengers can be viewed as producers of passenger information as well as consumers. UbibusRoute (Vieira et al., 2012) uses information from social networking sites to recommend routes to users, thus supporting them in their decision making. Based on the context of the user and of the route and buses, the application computes the possible routes for individual users to reach their destination, indicating on a map the route to follow. Although real-time personal applications are the most direct tool for supporting travelers in their decision process, social networking media can also be used for more general purposes than real-time information and can involve users directly in the overall process of improving public transport. A pioneering example is provided by the Bus Meister project (Greencitystreets, 2013), which uses an on-line game, social networking, and a wiki to teach people how to improve public transport. The aim is to involve people in the improvement process in order to stimulate creative thinking and generate the political support needed to implement good ideas.

3. Infomobility

The specific use of information and communications technologies to support the mobility of people is generally known as "infomobility". This sector, which offers interesting examples of adoption of methods and technologies involving users in both unaware and active mode, is growing in importance, thanks in part to the diffusion of satellite navigation on nomadic devices. Infomobility informs people in real time of current traffic conditions or the departure time of the next bus or train. They receive the information on panels or directly on their own mobile phones.

Advanced infomobility would include information on customers – detailed, accurate, automatically collected information on historic travel patterns (both aggregate and for individual users) as well as real-time location and trip itineraries. This advance includes not only the data but powerful, easy-to-use systems for data analysis. Information for customers would be personalized, accessible anywhere, very accurate, real-time, and provide comprehensive modal options with cost and travel time comparisons.

Reactive user-oriented services can significantly improve the quality of service, especially for such communities as older people, or people with disabilities, or people with very limited budget, who are much more dependent on these services and their support infrastructures. Characteristics of these systems are:

- Two-way information;
- Greater sense of community between riders and transit agency;
- Agency strongly adaptive and networked;
- Agility in provision of services;

- Creation of new knowledge along with users;
- Commitment of needed resources.

Personal traveler assistants based on user preferences are now available. Users can choose among different criteria to compute the best route – quickest, shortest, best for sightseeing, most economical. They can also specify constraints or preferences, such as favor motorways, avoid tolls, avoid vignettes, avoid off-road connections (e.g., ferry, train). A few decades ago, a multi-criteria approach was introduced to compare heterogeneous alternatives by applying Analytic Hierarchy Process (Carrese et al., 1992) and proposed again recently (Byung-Ki et al., 2009; Nadi & Delavar, 2011; Bozkurt et al., 2012). Personalized traveler assistants can be enhanced by introducing self-learning rules, such as machine learning and neuro-fuzzy methods (Pang et al., 1999; Lin et al., 2009).

The ability to understand personal preferences is an important feature of advanced information systems. A transportation system is a large interconnected network where many possible journey choices are available. Complete information on the transport network would require an enormous quantity of data and would be difficult to interpret. We need think only of the large number of transit lines and possible transfers as well as possible park-and-ride at different parking lots. On the other hand, mobility of persons is a multifaceted phenomenon, which aggregates numerous personal needs and which can even change depending on trip-specific or day-specific conditions, such as the need to accompany an elderly person or bad weather. Personalized real-time information will allow reducing the amount of information supplied to each user by extracting only information relevant for the user and for the specific goal of his or her journey.

The main characteristics of advanced infomobility are:

- Centralized, complete, real-time, easily accessible, multimedia, and pervasive information;
- User-tailored information on supply and demand of different modes of transport, with comparison of costs, time, reliability, and impacts;
- Exchange of information in two-way interaction with users to improve service.

The new technologies allow for real-time information exchange between users and service providers. Users can function as sensors within the system, feeding in a range of information. Transit services can leverage the devices users carry to push out dynamic information, e.g., alerts, accidents, and information tailored to individual user habit and location.

It is possible to identify five levels of information with an increasing level of participation and completeness:

- Level 1. Static information on supply: historical 1-way information on line routes and scheduled timetable;
- Level 2. Dynamic information on supply: updated 1-way information on bus positions and arrival times at bus stops;
- Level 3. Dynamic information on supply and demand: updated 2-way information on bus positions and arrival times at bus stops, as well as number of on-board users and empty seats;
- Level 4. Dynamic cooperative information: updated multilateral real-time information exchange from mobility agency to users and vice versa as well as among users; this allows users to share first-hand information on system performances, thus shortening the time lag between data measurement and information supply;
- Level 5. Dynamic adaptive system: integration of multilateral communication and transit operations; these allow dynamic adjustment of transport many-to-many supply to time-dependent users' needs (demand adaptive transit, timed transfer systems, complex bus priority strategies, advanced self-organizing personal transit systems).

An example of Level 5 is provided by the advanced car sharing system, which is based on automated or semi-automated vehicle operation and maintenance. Advanced car sharing is based on automated or semi-automated vehicle operation and maintenance. This includes driverless operation in non-dedicated rights-of-way (e.g., in mixed traffic), which is becoming a reality (see for example http://www.citymobil-project.eu). It improves safety and reduces labor costs and vehicle downtime. It also includes vehicles that diagnose and repair themselves (via supporting robotic or other autonomous maintenance systems). The main characteristics of automated vehicles are: short trips, complementarity with alternative transport, self-service cars (no reservation + easy to use + door-to-door service), one-way (pick-up and drop-off anywhere in area), and carbon-neutral fleet.

Under advanced car sharing, on picking up a car, the user can also book a slot at the drop-off destination, if one is available. This service might at times require considerable redistribution of vehicles, for which advanced platooning could be a solution. A number of automatic vehicles could be shifted from place to place platooned behind a single lead vehicle.

4. Empowering the User

The users may participate in various forms in the design and management of services. Kuusisto and Päällysaho (2008) describe four different user roles in co-production of a services: (1) consumer: the use of services generates the value that motivates the actual provider; (2) co-performer: the user performs some tasks essential for the service; (3) co-creator: user exchanges opinions and ideas, gives advice or guidance and consultation; (4) co-designer: there is a constructive discussion between customers and provider.

An extreme approach may be for users to co-produce the services that they use. With the “Tiramisu” application for smartphone, Zimmerman et al. (2011) show how in the Port Authority of Allegheny County bus users track positions and occupancy levels. This is actually a radical solution in which there is not just a design but actual data collection, and the connection costs are covered by the users themselves.

Referring to co-designer, the user role must fit into the design process. In their seminal work, Nonaka and Takeuchi (1995) present the SECI model, addressing the issue of knowledge creation within organizations. They argue that the collaborative process that builds new knowledge, for example in a company, is based on a cycle of four fundamental steps – Socialization, Externalization, Combination, Internalization – where workers in the organization use, share, assimilate, and transform knowledge of two possible types, Explicit and Tacit. This model is conceived to describe the way that organizations innovate their products and processes through the activity of their employees.

Interestingly, the notion of user as active autonomous agents allows users to participate in the innovation process. That is, the users can be involved in the knowledge creation activity in two specific steps. Users learn either by Internalization (reading instructions and watching directions) or by Socialization (asking, looking around, or simply following other users who already know). In our case, using public transport involves users in a long-lasting Socialization phase, where the experienced users have time to try and compare several alternatives.

For the Public Authority (PA) and Service Providers (SP), a first possible way of taking advantage of the trained users is to observe their behavior, at least in a statistical form, or individually – for those users who are willing to participate in the process of knowledge creation. This deliberate participation can be expressed in a way similar to when a user confirms an authorization for some app downloaded on the smartphone or when a user navigates on the Internet by enabling “cookies”, which track his/her behavior.

But there can be a second, more active participation in knowledge creation. Some users may be inclined to discuss with other users, and refine their point of view up to the point of suggesting (i.e., Externalizing) possible improvements and solutions that compete and surpass the designers’ point of view.

Therefore, users can participate in the design process either as observed actors, more or less unaware that they are being monitored by service providers, or as active agents who experience the services, collect and elaborate opinions, and suggest possible improvements.

In both cases, there is an important shift in the scenario that makes viable solutions that were not realistic a few years ago. The increasing demand from customers – spurred by their own private interest – for pervasive wireless communication services through mobile telephones, computers, and sensors has boosted the development of networks, as well as the features and performances of these devices, which most users carry. As the density of wireless-enabled devices increases, they can be used to implement solutions aiming at public interest, and nourish user willingness to participate. Examples of such developments have favored the introduction of wireless technology for public transport in a number of components of ITS, in Automated Fare Collection Systems, and many others. Here we emphasize only that currently there are several opportunities of communicating with the user in both ways, and users are increasingly inclined to rely on these personal devices to access services and share information with other users and with organizations, either anonymously or in their own names.

Smartphones, with their many onboard sensors and an amazing variety of available apps, are replacing planners, alarm clocks, compasses, flashlights, and any number of other tools in common use. Combining the typical features of a navigator and an agenda, together with capabilities as a general-purpose computer with reasonable memory resources, plus wireless and 3G connections, more and more services that are naturally related to mobility are becoming popular. In large urban areas, as they move from place to place, people often find new opportunities to use time intelligently, doing several errands at a time.

Information technology can support the involvement and the empowerment of the user in various ways. We will comment on few of the approaches and models that can be adopted in the relationship between SP and their customers/users to involve users in various ways and, ultimately, to empower them.

Collecting a realistic map of mobility demand, such as the origin-destination matrix, is usually an expensive burden for traffic experts and managers, often pushing them to adopt techniques for estimating it. Using individual devices as anonymous probes and collecting the tracks of shifts along with time stamps provides a collection of data on the actual mobility demand. From this, a number of data management and analysis techniques can be used to cluster customer mobility patterns and preferences, developing new powerful tools for the design of transit services.

Social networks. The Social Network Analysis approach is becoming surprisingly pervasive. Herbert A. Simon (1955), 1978 Nobel laureate in Economic Sciences, offers this: “No one supposes that there is any connexion between horse-kicks suffered by soldiers in the German army and blood cells on a microscope.” The ubiquity of personal or vehicular devices with two-way communication capabilities, paired with GPS devices, is providing the basis for fostering a number of applications that gather information from individual devices as probes of traffic speed, or – more in general – collect location-based information on, say, opinions on points of interest or commercial activities.

Interesting social networks – something that sociologists have been studying for more than a century – are not just those based on the explicit declarations by each “node”, according a model that Facebook has made very popular. A social network can be based on any “social behavior”, such as telephone calls or patronizing the same shop or liking the same kind of food or even being within a certain physical distance. Also, a combination of features may provide a social link, like being “friends” on Facebook, and within a given distance. In this wider concept of Social Network, collecting data about mobility of individuals may offer insight into reality and build up a “network” of interests tuned to specific needs – possibly of public or commercial interest. In any case, the challenge is to collect “big data” about people, their behavior, and their taste (what they “like”, in the Facebook sense), or clicking stars are simple instant actions that make it possible to collect popular wisdom. Matching tastes, whether they are expressed explicitly or not, allows the analyst to build up social links. By matching similarities, it may be possible to identify a need that people on the move will want to satisfy “here and now”.

Open Data. This is the initiative of making useful data of public utility freely available to everyone for any kind of use – even commercial – without restrictions. This opportunity for developers, possibly motivated by private interest, is changing the scenario in many areas. A remarkable example is Google (not a public body), whose Google maps and Application Programming Interfaces have fostered the creation of software in a number of fields by dramatically reducing the cost of releasing map-based and location-based services.

Most Public Transport Service Providers collect real-time information by tracking their buses for a number of management reasons. Starting from this information, many organizations have already begun to develop well-tuned applications for mobile users, sometimes with excellent results. Unfortunately, the financial burden of such developments, as well as keeping up with the developments in mobile technology, is beyond the financial capacity of most providers.

The idea is that Open Data, making available data related to public transport, has an impact on the application development market and possibly also to the actual delivery of such data to end users. The services that can be conceived based on mobility data are unlimited. The available public data make possible and reduce dramatically the cost of developing applications that deliver customized information to end users. Likewise, the large number of people with the double role of travelers and customers, each with a detailed profile of needs, represents an appealing potential market.

The idea of providing services for free on the Internet potentially to an enormous number of customers has given rise to phenomena – such as Google and Facebook – with multibillion-dollar/euro business activities that originate from a basic need (information, communication) paired with services that are profitable for the provider with marginal impact for the end user. Similar business models, based on advertisement, value-added services, or minimum fees from the end users, are already feeding the market of mobile applications that aim to satisfy the need for travel information while delivering various kinds of value-added services.

Crowdsourcing. This is a distributed problem-solving technique that involves a network of people, "the crowd", to gather collective intelligence (Surowiecki, 2004). Crowdsourcing is a result of evolving ICT and Web. Academic researchers have only recently begun to investigate it. The concept of collective intelligence has been popularized as the wisdom of crowds (Brabham, 2012). The dialogue between Public Authority (PA), Service Provider (SP) and users (U), enabled by the new technologies, produces a dynamic with input, output, and feedback that empowers the user as an active agent. Figure 1 illustrates a crowdsourcing process in eight steps.

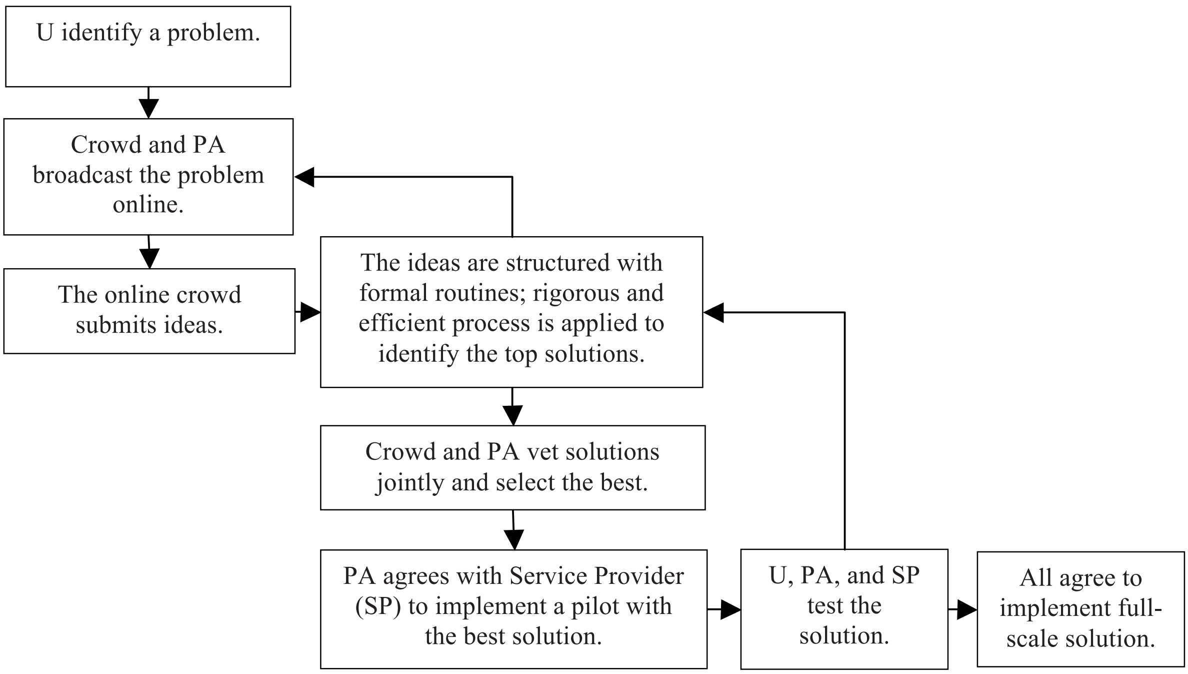

Fig. 1. Steps of a crowdsourcing process

The identification of problems is a bottom up exercise. The problem will be accepted, altered, or rejected by the crowd. If the problem is judged relevant the crowd and the PA will broadcast the problem and can activate also more conventional ways to attract the attention of a large community. The online crowd submits ideas in a structured way with the assistance of a sort of online toolkit for a rigorous, efficient and selective process from the ideas to the solutions. The crowd and PA select the best solution jointly. The next step is to implement a pilot, to evaluate it, after a period of weeks or months, and decide on the results to have a full-scale implementation. In that way problems and ideas are submitted continuously, if the process is positive with practical and better applications the crowd is expanding and changing all the time.

User motivation. The most important element for a crowdsourcing application is a vibrant and engaged online community. But this is one of the major challenges. To attract users to online communities is not an easy task in the Internet environment. The start-up online community is an immature, lifeless space unworthy of the attention of a new visitor. But on the contrary a very active community is to an excessive degree too powerful for an outsider to penetrate. Public relations and marketing cannot guarantee visitors to a Web site. And once people start visiting a site, retaining their interest is a challenge in itself. The competition of citizen and stakeholder attention on the web is fierce (Antikainen & Väätäjä, 2008).

There are two main initial steps to building an online community. The first step is information giving and gathering through public information material, telephone and broadcasting, social networks and interviews. The second step is interactive engagement with information events, focus groups, workshops, and stakeholder conferences.

To facilitate the citizen and stakeholder involvement, the online community should have from the beginning a clear purpose and know what attracts the citizens and stakeholders, it is important to understand their motivations. All participants should have an active role. They should become part of democratic process were they can express ideas and concerns, take ownership of ideas, contribute to creative and innovative solutions. The process should be time and cost-effective, easy to be funded, perceived as necessary. The decisions are made in the community and all questions should find an answer. The opposed stakeholders should be helped to converge on the same solutions. Once the community has scaled up, users will guide on how to expand the purpose. A purpose road map can be helpful to show how social collaboration will advance over time. A good purpose should draw people directly to participate. Users should easily grasp its importance and the value of participating. The value must come from the community. Purpose should align with community values, not try to change it. The success of a good purpose must be measured.

5. Citizen innovation in public transport services

PTSP are motivated by private interest. The user is passive, and the public authorities, regions, and municipalities may abdicate their responsibilities or, worse, collude with the PTSP.

The near monopoly enjoyed by PTSP can lead to a decline in service performance and patronage. Under an absolute monopoly, all users – who have no alternative transport means – are motivated to demand better service. But when the more exigent and higher-income users can easily shift to car use if PTSP fails to satisfy, those who remain, the less-advantaged majority of users, usually have little choice but to accept the level of service offered. In other words, a near monopoly usually performs worse than an absolute monopoly. This has enormous and wide-ranging implications (Sethi, 2010).

For each passenger lost to the private car – using the same infrastructure – service becomes a little worse and the roads that more congested. The effect is a cumulative decay with dynamic externalities (Baumol, 1967). Meanwhile, major challenges for public services emerge, such as the aging of the population, challenges in funding citizens' mobility needs, and increasing productivity, quality, and sustainability of services.

Therefore to consider the "countervailing forces" that can arrest and reverse such a decline, the public authorities should act fast and vigorously, taking advantage of traditional and innovative measures.

Traditional measures are those imposed on PTSP with a view to influencing attitudes towards improvements and innovations in the transport services in general and particularly related to what the users require. These can be divided into financial instruments (e.g., tax incentives, financing for R&D, and innovation projects), technical measures (e.g., standards for pollution, information, comfort, and reliability), and regulatory measures (e.g., competition as driver of innovation, performance-based contracts with penalties for delays, cancellation of services and lack of user information, and rewards for results measured against benchmarks). These measures are closely related to more efficient and equitable transport services.

Innovative measures are designed to support user-driven improvements and innovations in the transport services. The user becomes active and counterbalances the power of the provider. These measures always include financial instruments (e.g., new financing criteria and new incentives), technical measures (e.g., open and interoperable ICT infrastructure, open data held by the public sector and readily usable), and regulatory measures (e.g., reform to empower citizens' influence and ability to make choices and to design services).

Figure 2 shows the provider of service motivations and type of users (Le Grand, 2003). The horizontal axis represents the spectrum of views about what motivates the PTSP, from extreme 100% public interest to extreme 100% private interest. The vertical axis represents the spectrum of user empowerment, from passive 100% individual to active 100% autonomous agent.

Policy makers have evolved from a social democratic point of view, whereby the PTSP was considered motivated by 100% public interest (circle 1), to a more realistic neo-liberal view of the presence of strong 100% self-interest (circle 2). According to this view, the policy maker should empower the user to be more active and counterbalance the providers (circle 3).

Given the right to exercise choice, users can influence the services. The public transport must be multimodal and intermodal: to go from A to B there must be choices with different time, comfort, and price. Given data and instruments to develop ideas, service innovators, user communities, and crowd can bring their own experiences and expertise into the process of public transport service innovation. User-driven innovations can improve the quality of public services, increasing the ability to supply tailored value-adding services.

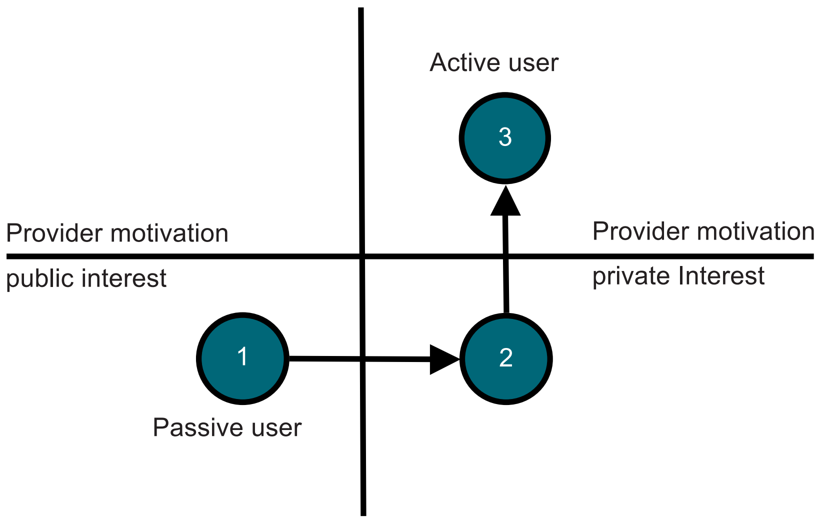

Fig. 2. Provider motivation and users (source: Le Grand, 2003)

The users should be empowered to influence the service, which will give flexibility to the system and foster bottom-up development. They can become partners in the design and innovation of public services, and they can become entrepreneurs in the exploitation of new services. There are differences among the stakeholders' relationships. The Group of Interest (GI) of Figure 1 exchanges information with the PA and has systematic relations through the toolkit, about their needs, evaluation and decisions. In general the PA introduces the collective intelligence and manages it.

The purpose of this process has to be carefully determined and cleared to all stakeholders. The process has to be consistent with the operational and funding capability of PA. The PA is between GI and PTSP, also if the latter has much knowledge and experience on operation and management of public transport. The PTPS should not be at the center of the process with its interest. The PA should empower the users to be more active and counterbalance the providers; its task is to filter the information from GI to PTSP adding its own evaluations and decisions.

It must be clear that if there are more costs for a new service, its implementation is a final decision of PA with the agreement of GI and PTSP. This hierarchy of decisions depends on the fact that the public transport are generally not economic sufficient and must be subsidized by the PA. With crowdfunding of the new services this perspective can change and the role of PA should be less central.

Figure 3 illustrates the innovation process in six steps and the interactions among the main actors. The process described is a distributed problem-solving technique that involves a network of people, "the crowd", to gather collective intelligence with intensive use of ICT and Web. It is a form of crowdsourcing, the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call.

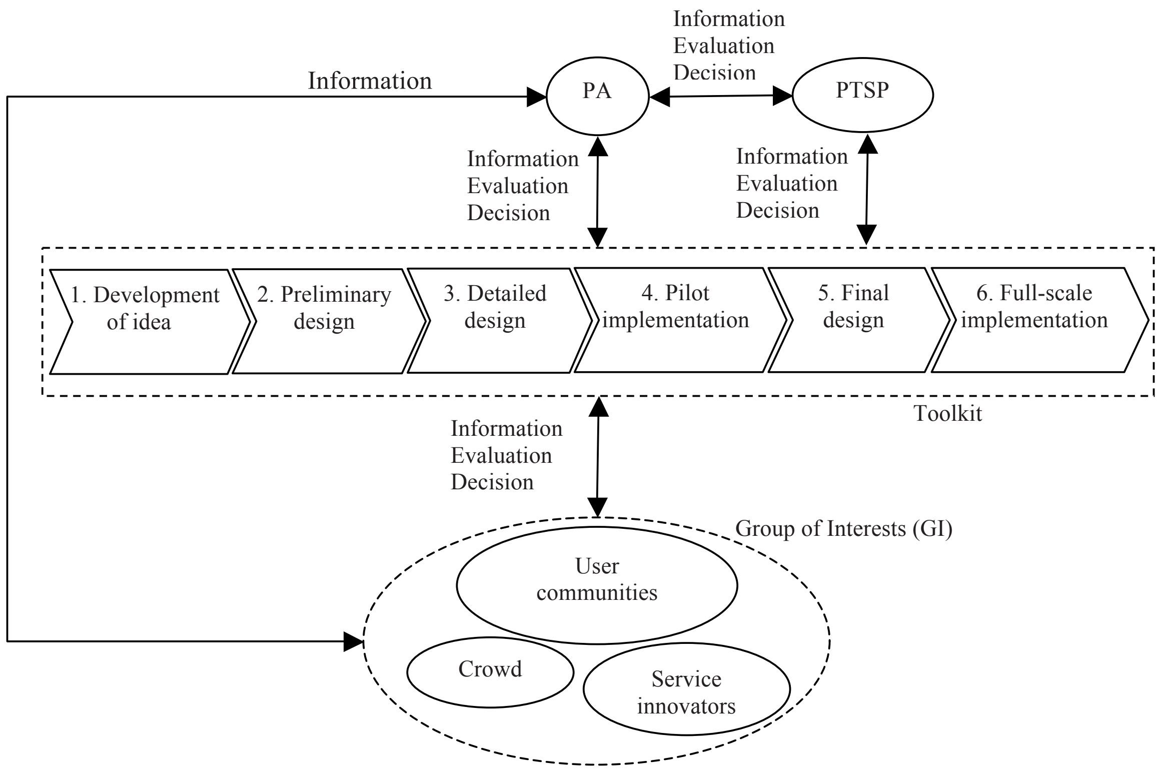

Fig. 3. The innovation process and the interactions

The main differences with respect to standard crowdsourcing are:

- It is user driven, motivated by the interest of the users, while standard crowdsourcing is motivated by the interest of a company;
- It is restricted to changes, improvement, and innovations.

The toolkit for user innovation is the backbone of the process. This is an emerging alternative approach in which the point is to first understand user needs in detail and second to change the service accordingly. Also, product and service development may be transferred to users. No longer is the aim to ask users about their needs and wants, then try to translate these into acceptable services. Instead, potential users are invited to take an active part in the development process. They are thus to be regarded as codesigners of their own services. Experience in fields where the toolkit approach has been pioneered show custom products being developed much more quickly and at a lower cost (von Hippel & Katz, 2002).

A first goal of the toolkit is to enable non-specialist users to develop their ideas and to design new and innovative services that meet their needs. The toolkit should have user-friendly features that guide users as they work. It is specific to the public transport services. If innovations are made cheaper and easier for users, they can increase the volume of new and innovative services.

A second goal is to facilitate interaction among the actors through a wide variety of online channels. The Internet increases the possibility of collaborative innovation with users by transforming one-way communication into persistent dialogue, by providing access to the social dimensions of user knowledge, and by extending users' reach and scope to interact with all the actors.

The innovator, alone or in a group, is the initiator of the process. He is supported in his activities by the innovation measures of the public authority, just examined, and is the main user of the toolkit. He receives information from all the actors, and his action is the engine of the innovation process, based on the toolkit. He has specific and direct interactions with the public authority, especially during the last two steps of the process.

The main actors are the user communities, like the commuters of some areas, or people with special needs, or employees of factories or clusters; the crowd is formed by the actual users and the potential users, currently car users, but any individual can be involved in the process. All interact by giving information and evaluating the different steps of the process. Some of them can move from this area to become user innovators.

The public authority is informed, but the main interventions are at the final design, to be approved, during and after implementation. The public authority can provide more support for citizens in order to empower them to participate in the process by assigning personal advisers to them.

The innovation can be related just to infomobility through Internet, Wi-Fi, and mobile. The whole process is thus much simpler and the public authority and users have the advantages. The public authority can have important applications related to information about the services at no cost or for very little in comparison with the high cost of its own infomobility system. The users can use a variety of different applications, some in competition. A good example is New York State's Metropolitan Transportation Authority (MTA), a complex transportation system that generates many different kinds of data, presenting an intriguing challenge for app developers. MTA is challenging developers to create new software applications to improve the transit experience of its 8.5 million daily riders (http://mtaappquest.com/).

The implementation of better services is important for the engagement of the online community. Services should be more attractive, user-oriented, and effective for aging populations and rural areas. They should change from supply push to demand pull. They should also consider the generality of the citizens and consequently reduce impacts, energy, and costs for the collectivity.

Better services can take advantage of some of the promising emerging technologies (Burt et al., 2008):

- hybrid and electric transit buses;
- nanotechnologies for automation, real-time exchange of information, and seamless integration of services;

- mechatronics for fuel economy, vehicle performance and safety, and streamlining maintenance;
- speech recognition and language translation for efficiency and effectiveness of transit customer service.

The provider's organization should be able to implement and manage the innovation, for this is important to attract high-skill workers, and to train employees continuously.

6. Final remarks

We have provided a review of the research that explores new development of ITS, ICT, and social networks as means to empower users and to improve public transport services.

The traditional view is that the designers of mass products and services are the experts, entitled to use the technologies for the companies and the customers. The modern most advanced multinational companies are adopting a different approach to great advantage: they ask their users to participate in the design of the products and services.

The paper accepts this approach and has described how to apply it to a specific sector, public transport services. This sector is generally protected, subsidized, not very customer-oriented, and on the decline in service performance and patronage, but it has strong corporative interest. In this scheme of near-monopoly, the user has a limited and passive role. For this reason the main initiators of this radical change should be not the providers, but the citizens and the public authorities, democratically elected for the benefit of the people.

A few important suggestions emerge from the paper to outline a strategy to empower users and improve public transport services. It can be summarize in three steps.

The first step is an open data approach to implement the principle that public administrations are required to release the data available. Diffusion of new information and communications technologies supplies a large amount of updated data on transit services as well as on users' positions, itineraries, destinations, and needs. Information *on* customers can be very detailed, accurate, automatically collected information on historic travel patterns (aggregate and individual). The approach is essential for the economic development of companies able to create new services from this data, exploiting the diffusion and continuous improvements of smartphones and tablets.

The second step in this direction is the development of apps dedicated to mobile and mobility for advanced infomobility. This consists of providing users with updated information about the current state of the transport system and, contextually, in a dynamic adjustment of multimodal transport services to specific needs received by users. The information *for* customers – personalized, accessible anywhere, very accurate, real-time, comprehensive modal options with cost and travel time comparisons, multimedia and pervasive. User-tailored information on supply and demand of different transport modes, with comparison of costs, time, reliability and impacts. The information is the result of the past knowledge of the user and the collective knowledge result from the exchanges between users. Users are provided with two-way communication media, so they can ask and receive personalized information from the system and communicate with one another to exchange information, remarks and suggestions, as well as to share needs and choices.

The third step is to empower the crowd, trained and active in the use of smartphones and ready to take part as codesigner of the services. The concepts of social networking and crowdsourcing have been introduced on the Web by the widespread use of ICT, which can be exploited to improve the level of service and the effectiveness of transit systems. Indeed, they enable users to cooperate in dynamic transit operations management by conveying their needs in real time and, furthermore, to participate even in the design process of the transit system. An innovative crowdsourcing design process has been introduced that collects and structures ideas provided by users and applies rigorous decision-making processes to select the top solutions and thus achieve full agreement on project implementation.

References

Abdel-Aty, M. A. (2001). Using ordered probit modeling to study the effect of ATIS on transit ridership. *Transportation Research Part C*, *9*, 265–277.

Antikainen, M., & Väätäjä, H. (2008). Innovating is fun: Motivations to participate in online open innovation communities. In Huizingh, K.R.E., Torkkeli, M., Conn, S. & Bitran, I. (Eds.), *Proc. of the First ISPIM Innovation Symposium Singapore: Managing Innovation in a Connected World.* Singapore, 14–17 December 2008.

Avineri, E., & Prashker, J. N. (2006). The impact of travel time information on travelers' learning under uncertainty. *Transportation, 33,* 393–408.

Baumol, W. J. (1967) Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis. *American Economic Review, 57,* 415–426.

Bozkurt, S., Yazici, A., & Keskin, K. (2012). A multicriteria route planning approach considering driver preferences. *IEEE International Conference on Vehicular Electronics and Safety,* 324–328.

Brabham, D. C. (2012). Crowdsourcing: A model for leveraging online communities. In Delwiche, A. and Henderson, J. J. (Eds.), *The participatory cultures handbook* (pp. 120–129). New York: Routledge.

Bregman, S. (2012). TCRP Synthesis 99: Uses of Social Media in Public Transportation. Washington, DC: Transportation Research Board.

Burt, M. W., Cluett, C., Schweiger, C. L., Coogan, M. A., Easley, R. B., & Easley S. (2008). Improving Public Transportation Technology Implementations and Anticipating Emerging Technologies. Transit Cooperative Research Program (TCRP) Report 84, *e-Transit: Electronic Business Strategies for Public Transportation, 8*. Washington, DC: Transportation Research Board.

Byung-Ki, K., Jung-Bok, J., Jong-Ryul, K., & Mitsuo, G. (2009). Optimal Route Search in Car Navigation Systems by Multi-objective Genetic Algorithms. *International Journal of Information Systems for Logistics and Management*, *4*, 9–18.

Carrese, S., Fusco, G., & Gori, S. (1992). Route Choice Behavioural Models Analysis of a Route Guidance System for a Congested Urban Area. *International Conference: Road safety in Europe*, Berlin, Germany, September–October.

Chaves, A. P., Steinmacher, I., & Vieira, V. (2011). Social networks and collective intelligence applied to public transportation systems: A survey. *VIII Simpósio Brasileiro de Sistemas Colaborativos* (SBSC 2011). Paraty, RJ, October, 2011.

Chorus, C. G., Arentze, Th. A., Timmermans, H. J. P., Molin, E. J. E., & Van Wee, B. (2007). Travelers' Need for Information in Traffic and Transit: Results from a Web Survey. *Journal of Intelligent Transportation Systems: Technology, Planning, and Operations*, *11*, 57–67.

Dziekan, K., & Dicke-Ogenia, M. (2010). Reducing uncertainty and supporting cognitive maps in travel information for public transport. *World Review of Intermodal Transportation Research*, *3*, 73–90.

Dziekan, K., & Kottenhoff, K. (2007). Dynamic at-stop real-time information displays for public transport: effects on customers. *Transportation Research Part A*, *41*, 489–501.

Ferris, B., Watkins, K., & Borning, A. (2010). OneBusAway: Results from providing real-time arrival information for public transit. *Proceedings of CHI 2010*. Atlanta, GA.

Greencitystreets (2013). http://www.greencitystreets.com/busmeister.

Grotenhuis, J.-W., Wiegmansa, B. W., & Rietveld, P. (2007). The desired quality of integrated multimodal travel information in public transport: Customer needs for time and effort savings. *Transport Policy*, *14*, 27–38.

Hickman, M. D., and Wilson, N. H. M. (1995). Passenger Travel Time and Path Choice Implications of Real-Time Transit Information. *Transportation Research Part C*, *3*, 221–226.

Holdsworth, N., Enoch, M. P., & Ison, S. G. (2007). Examining the Political and Practical Reality of Bus-based Real Time Passenger Information. *Transportation Planning and Technology*, *30*, 183–204.

Kuusisto, A. & Päällysaho, S. (2008). Customer Role in Service Production and Innovation: Looking for Directions for Future Research. Research Report 195. Lappeenranta (Finland): Lappeenranta University of Technology.

Le Grand, J. (2003). Motivation, agency, and public policy: Of Knights and Knaves, Pawns and Queens. New York: Oxford University Press.

Lin, I., Chou, S. & Hsu, H. (2009). Developing Adaptive Driving Route Guidance Systems Based on Fuzzy Neural Network. *IEEE International Conference on Systems, Man and Cybernetics*, *1-9*, 4293–4298.

Lyons, G., & Harman, R. (2002). The UK public transport industry and provision of multi-modal traveller information. *International Journal of Transport Management*, *1*, 1–13.

Marjanovic S., Fry, C., and Chataway, J. (2012). Crowdsourcing based business models: In search of evidence for innovation 2.0. *Science and Public Policy, 39,* 318–332.

Molin, E. J. E., & Timmermans, H. J. P. (2006). Traveler Expectations and willingness-to-pay for Web-enabled public transport information services. *Transportation Research Part C*, *14*, 57–67.

Nadi, S. M., & Delavar, M. (2011). Multi-criteria, personalized route planning using quantifier-guided ordered weighted averaging operators. *International Journal of Applied Earth Observation and Geoinformation*, *13*, 322–335.

Nelson, J. D., & Mulley, C. (2013). The impact of the application of new technology on public transport service provision and the passenger experience: A focus on implementation in Australia. *Research in Transportation Economics*, *39*, 300–308.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Nunes, A. A., Galvão, T., Falcão, Cunha, J., & Pitt, J. (2011). Using social networks for exchanging valuable real time public transport information among travellers. *Proceedings of the 2011 IEEE 13th Conference on Commerce and Enterprise Computing*, 365–370.
Pang, G. K. H., Takahashi, K., Yokota, T., & Takenaga, H. (1999). Adaptive route selection for dynamic route guidance system based on fuzzy-neural approaches. *IEEE Transportation Vehicle Technology*, *48*, 2028–2040.
Sethi, R. (2010) The Astonishing Voice of Albert Hirschman. http://rajivsethi.blogspot.it/2010/04/astonishing-voice-of-albert-hirschman.html.
Simon, H. A. (1955). On a class of skew distribution functions. *Biometrika*, 42:3-4, 425–440.
Skoglund, T., & Karlsson, I. C. M. (2012). Appreciated – but with a fading grace of novelty! Traveller's assessment of, usage of and behavioral change given access to a co-modal travel planner. *Transport Research Arena Europe 2012, Procedia - Social and Behavioral Sciences*, *48*, 932–940.
Sun, R., Yu, H., Du, Y., & Geng, S. (2013). The analysis of behavioral responses to transit information. *Applied Mechanics and Materials*. *253-255*, *Issue PART 1,* 1431–1437.
Surowiecki, J. (2004). *The Wisdom of Crowds*. Garden City, NY: Doubleday.
Tang, L., & Thakuriah, P. (2012). Ridership effects of real-time bus information system: A case study in the City of Chicago. *Transportation Research Part C*, *22*, 146–161.
Vieira, V., et al. (2012). The UbiBus Project: Using Context and Ubiquitous Computing to build Advanced Public Transportation Systems to Support Bus Passengers. *VIII Simpósio Brasileiro de Sistemas de Informação*. São Paulo, 16–18 May 2012.
von Hippel, E., and Katz, R. (2002). Shifting innovation to users via toolkits. *Management Science, 48 (7)*, 821-833.
Watkins, K. E., Ferris, B., Borning, A., Rutherford, G. S., & Layton, D. (2011). Where Is My Bus? Impact of mobile real-time information on the perceived and actual wait time of transit riders. *Transportation Research Part A*, *45*, 839–848.
Zimmerman, J., Tomasic, A., Garrod, C., Yoo, D., Hiruncharoenvate, C., Aziz, R., Thiruvengadam, N.,R., Huang, Y., & Steinfeld, A. (2011). Field Trial of Tiramisu: Crowd-Sourcing Bus Arrival Times to Spur Co-Design. Proceedings of the ACM International Conference on Human Factors in Computing Systems, CHI 2011, Vancouver, BC, Canada, May 7-12, 2011. New York: Association for Computing Machinery.